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ON THE QUESTION OF THE VECTORS OF
CRIMEAN HEMORRHAGIC FEVER

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In the summers of 1944 and 1945 in the Crimea, there was observed a singular disease of acute febrile type, with a strongly expressed hemorrhagic syndrome, a disease which took a grave course and had a fatal outcome in a large percentage of cases. The regions most heavily hit were the steppe districts of the western part of the Crimea, in particular the Chernomorski, Novoselovski, Razdol'ski and Oktiabr'ski districts and, on the Kerch Peninsula, Lenin District. In the summer seasons of 1944 and 1945 in these districts there were as many as 200 cases of "Crimean hemorrhagic Fever."

As was established by the expedition sent there by the Medical Academy of Sciences under the leadership of Prof. M.P. CHUMAKOV, this disease has an ultravirus etiology. The vector of the ultravirus is the tick *Hyalomma marginatum* Koch.

The author of the present paper, participating directly in the work of the expedition which studied this disease, investigated the species-composition and degree of tick infestation of animals and birds, and also carried out observations on the seasonal variation of tick population and on the behavior of the ticks.

I. RODENTS

The species-composition of the rodent population in the infected districts investigated was as follows:---

- 1) The domestic mouse, *Mus musculus* L;
- 2) The mouse *M. musculus hortulanus* Pall;

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- 3) The vole *Microtus socialis* Pall;
- 4) The ordinary vole *Microtus arvalis* Pall;
- 5) The small ground-squirrel *Citellus pygmaeus* Pall;
- 6) The grey rat *Rattus norvegicus* Erxl;
- 7) The hamster *Cricetus cricetus tauricus* Ogn;
- 8) The large jerboa *Allactaga jaculus* Pall;
- 9) The European hare *Lepus europaeus transsylvanicus*

In an investigated 12,000 hectares of terrain in the foci of the disease, the density of the rodent population in the summer of 1945 was lower than the density in the summer of 1944. Thus in an area of 1 hectare the density of ground-squirrel burrows was as high as 300 in 1944 and not greater than 12 in the most populous sections in 1945. The density for voles per hectare {for these years} was 300 and not more than 100 respectively. The respective densities were for *Mus musculus hortulanus* 350 burrows and not more than 120 burrows.

The density of the hare population had markedly decreased. In 1944 one encountered 8 hares per km; in 1945, only 3. The number of trails found per hectare was 12 and 5 respectively. (To determine the density of the hare population, the method used was to illuminate a number of test areas at night with auto headlights).

The decrease in the rodent density was generally at the expense of species living in the fields. The cause of this marked decline in 1945 was most likely the winter of 1944/45, with its heavy rainfall and frequent icing up, which wreaked havoc among the rodents dwelling in burrows in the fields. This is confirmed by discoveries of decomposed corpses of rodents in old burrows excavated. Thus, of 125 excavated burrows, 18 contained rodent corpses.

Of grey rats, hamsters and large jerboas, there were only insignificant numbers, both in 1945 and in 1944. No mass mortality among the rodents was observed in the summer seasons of 1944 and 1945.

Of the rodents, those given the most intensive study were the hares, which we suspected as carriers of Crimean hemorrhagic fever. Investigations begun in June revealed the presence, on all hares, of a great number of sexually immature forms larvae and nymphs of the tick *Hyalomma marginatum*.

These larvae and nymphs do not attack humans, cattle and horses, but feed on hares and to some extent on birds. In the second half of June and the first half of July, we found still-hungry larvae and nymphs on our hares; from August through October, we found fully gorged larvae and nymphs. On other rodent species, no tick larvae or nymphs were detected.

During the summer season, hares keep away from dwellings, occasionally approaching inhabited premises at night only. As soon as cold weather sets in, the available food decreases, particularly after a snow-fall, and the hares migrate to the neighborhood of settlements, where they feed around the hay stacks, often manage to get into the barns, and hang around in the wind-breaks. In this season the collective-farm people not only shoot them around the hay-stacks, but kill them at night with sticks.

Hares are a nocturnal animal. At night they go out after food, and by day they lie up on the steppe-lands in weed-patches, where they feel themselves safe. In the rainy autumn season, they prefer the solid soil of unbroken ground, which does not get soaked and will not stick to the furry paws of the hare. It is likewise these bits of unbroken terrain which, during the summer season of the subsequent year, become most densely populated with ticks, since it is mainly in the autumn habitat of the hares that the gorged tick nymphs drop off the animals for their winter hibernation.

In the spring, the gorged nymphs of the tick *H. marginatum* enter the stage of sexual maturity; they infest cattle, sheep, horses and also humans. According to our observations, the ticks will turn and crawl in the direction of a man standing in one place, detecting his presence at a distance even of 10 to 12 m. If the man shifts his position slowly, the ticks will follow him.

Adult ticks, after gorging themselves with the blood of an animal (a cow or a horse), drop off; the females deposit their eggs, from which the larvae later emerge, infect the hares, and develop into nymphs. On birds, no fully gorged nymphs of the *Hyalomma marginatum* tick were observed by us.

We devoted a great deal of study to the species-composition of the ticks and to the seasonal variation in their numbers. In the western steppe regions of the Crimea, we found only one *Hyalomma* species, *H. marginatum*. The highest peak in the population of this species is reached at the beginning of July, when it may be considered to be the only species present, since the other types are not yet showing any activity: during this season we were able to get only isolated specimens of *Haemaphysalis*. In the early spring and late autumn seasons, *Haemaphysalis* and *Dermacentor* ticks are found here in small numbers (one or two specimens per thousand).

On the Kerch Peninsula a larger percentage of ticks of the *Dermacentor* and *Haemaphysalis* species is found; also ticks

of the species *Rhipicephalus*. Thus at the point hit by the disease on the Kerch Peninsula, the collections made in September 1944 showed 87.4% of the adult stages of *Hyalomma marginatum*, 9.4% of *Haemaphysalis punctata* Can. and Fanz., 1.5% of *Dermacentor marginatus* Sulz, and 1.7% *Rhipicephalus sanguineus* (S.P. Piontkovskaya's findings). In the November collections, ticks of the *Haemaphysalis* species predominated, then *Dermacentor*, and in lesser numbers, *Rhipicephalus* was found, while ticks of the *Hyalomma* species had declined to a few isolated specimens. Greater numbers of ticks of the *Dermacentor* species were found in November 1944 on sheep in the Staro-Krymski District.

In the summer seasons of 1944 and 1945, during the period of highest population, *Hyalomma marginatum* ticks, in the western steppe regions of the Crimea, were encountered in greatest numbers on the hard ground of fallow land, by stacks of last year's hay and straw, and along the windbreaks, particularly if these windbreaks were bordered by fallows or hard ground overgrown with grass and weeds. There were also many ticks on ground where farm animals stood.

A man, after sitting for an hour's time on the grass or stubble in any of the areas of most intense infestation, would remove from himself as many as 120 non-engorged adult ticks, while in an ordinary area he would remove 8-12 ticks.

Starved adult *Hyalomma marginatum* ticks collected on the steppe and brought to Prof. Chumakov's laboratory were found upon investigation to be infected with the ultravirus of Crimean hemorrhagic fever. Since in the nymph stage the ticks sucked the blood only of hares and possibly birds, we were forced to conclude that they either received the virus from these vertebrates or that they were infected transovarially. Light was shed on the first of these conclusions in 1945: from nymphs collected from *L. transylvanicus* and brought to his laboratory, Prof. Chumakov isolated the ultravirus of Crimean hemorrhagic fever. Nymphs collected from birds did not yield the virus. The question of transovarially transmission has not yet been decided.

II. CARNIVORES AND INSECT-EATERS

Beside the rodents, observations were made on carnivores and other mammals. Among the steppe-dwelling carnivores found here are foxes (*Vulpes vulpes*), skunks (*Putorius* sp.), weasels (*Mustella nivalis*) and wolves (*Canis lupus*). In 1945, carnivores of these species had multiplied in comparison with the year 1944, a fact which, it seems, is closely connected with the abundance of food in the form of rodents. For the weasels and skunks, the rodents of the mouse type served as food, while the foxes and weasels fed on the hares, which rain or frozen ground

made an easy prey.

On the said carnivores and likewise on dogs, neither the adults nor the nymphs of *H. marginatum* were found.

As for insect-eating species, hedgehogs (*Eriacus europaeus*) and bats were found, the latter in large numbers; no *H. marginatum* ticks were discovered on either of them.

III. BIRDS

Since Hyalomma ticks in the immature stages were found (in small numbers) on certain species of birds, studies had to be made of the species-composition and area of distribution of birds. The following species were investigated by us in the steppe districts in the western part of the Crimean peninsula:---

1) The crane (*Grus grus*), here found in large numbers. The birds examined were caught by the workers of a grain-growing State Farm. On two occasions 2-3 nymphs of *H. marginatum* were found on young cranes, in the neighborhood of the head. These birds emigrate in winter to India and Siam.

2) The prairie lark *Melanocorypha calandria* lives on the Crimean steppes in large numbers and on a non-migratory basis. In the summer season the larks stay out on the steppe; in the autumn they move nearer to human habitations; in winter they are found as permanent guests in farmyards and cattle corals. Larvae and nymphs of *H. marginatum* were in several instances removed from these larks.

3) The grey partridge (*Perdix perdix*) takes shelter in windbreaks and weed-grown patches. Toward autumn on the steppes of the Crimea, this species increases in numbers, because in addition to permanent residents, partridges from the more northerly districts flock in for the winter. Nymphs of *H. marginatum* were found in small numbers on these partridges.

4) Tick nymphs were discovered on domestic chickens and on sparrows.

5) In addition to the species enumerated above, we also examined the following birds: the common hoopoe (*Upupa epops*), the merlin (*Cerohneis vespertinus*), the prairie kestrel (*Cerohneis naumanni*) and owls (*Oarine passerina*). One or two specimens of each of these birds was obtained. No ticks were found.

CONCLUSIONS

1) Of the rodents of the Crimea the only one on which we discovered larvae and nymphs of the tick *H. marginatum* was the hare *L. europaeus transsylvanicus*. When ticks nymphs which had fed on these hares were examined in the laboratory, it was found that the ultravirus of Crimean hemorrhagic fever could be extracted from them.

2) In the autumn season, the hares prefer to lie up and feed on hard fallow ground and by haystacks. It is in these spots that the greatest density of *H. marginatum* ticks is observed in summer months.

These spots also constitute the most dangerous foci for the infection of humans with Crimean hemorrhagic fever.

3) Some of the hares will come close to dwelling-premises; consequently the possibility is not excluded that they may bring infected ticks into settlements.

4) Study of birds in the districts where cases of the fever are reported is of very great significance, both from the point of view of the possibility of their acting as vectors of Crimean hemorrhagic fever and likewise from the point of view of the dissemination of the infected immature stages of *H. marginatum* ticks.

5) As to whether the ticks are infected from the hares and whether the ultravirus of Crimean hemorrhagic fever may be transovarially transmitted, these are questions which require further study on the part of virusologists, zoologists and parasitologists.

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